US009304958B2

(12) United States Patent
Kreuzer

(10) Patent No.: US 9,304,958 B2
(45) Date of Patent: Apr. 5, 2016

(54) **DEVICE FOR TRANSMITTING SENSOR DATA**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 280 days.

(21) Appl. No.: **13/749,385**

(22) Filed: **Jan. 24, 2013**

(65) **Prior Publication Data**

US 2013/0198428 A1 Aug. 1, 2013

(30) **Foreign Application Priority Data**

Jan. 27, 2012 (DE) 10 2012 201 170

(51) **Int. Cl.**
G06F 13/00 (2006.01)
G06F 13/36 (2006.01)
H04Q 9/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 13/36*** (2013.01); ***H04Q 9/00*** (2013.01); *H04Q 2209/845* (2013.01)

(58) **Field of Classification Search**
USPC 710/306, 315, 316
See application file for complete search history.

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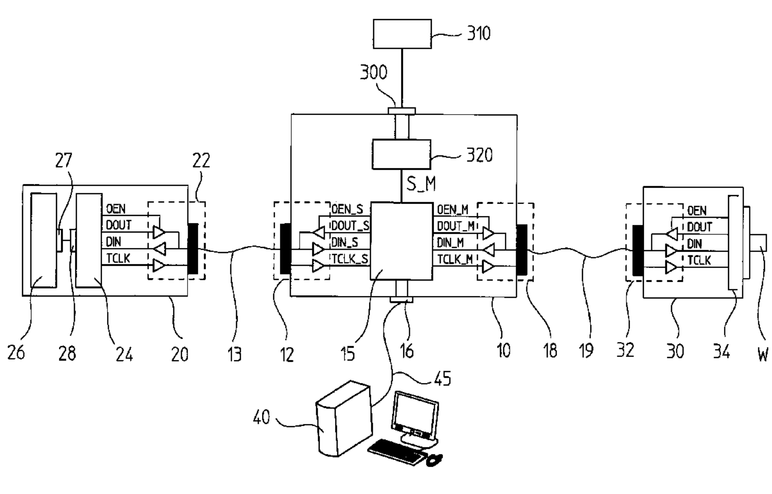
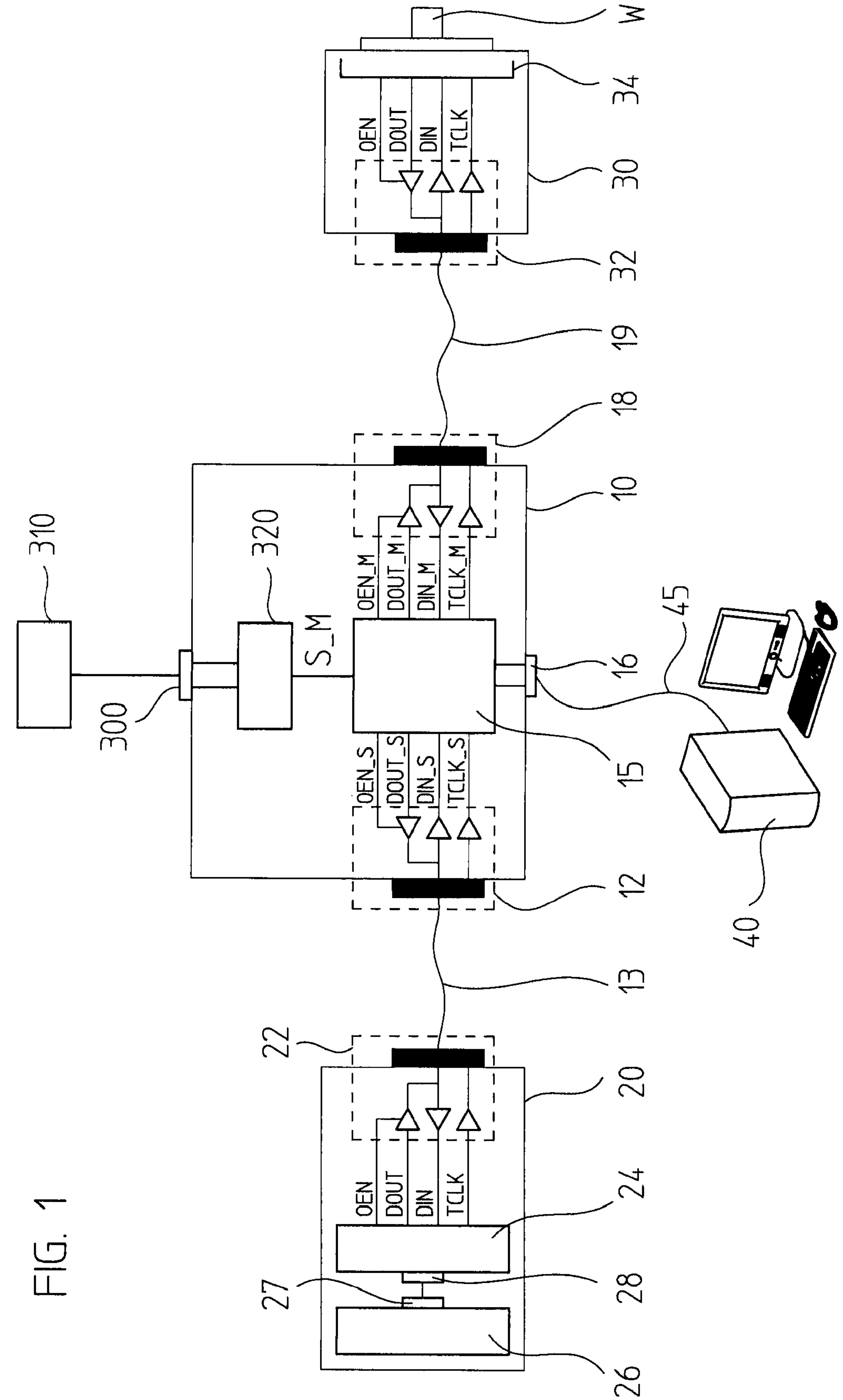
(57) **ABSTRACT**

A device for transmitting sensor data, includes a slave interface connectable to a master interface of a control device, a master interface connectable to a slave interface of a measuring device, at least one sensor interface connectable to a sensor, and a circuit configuration including a manipulation unit and protocol unit. A master-data input signal of the master interface and a sensor-data output signal are supplied to the manipulation unit, which outputs a slave-data output signal to the slave interface. At least one protocol-relevant interface signal of the slave interface or the master interface, and a sensor-data signal of the sensor interface, are supplied to the protocol unit, which generates the sensor-data output signal and, based on manipulation rules and the at least one protocol-relevant interface signal, selects when the manipulation unit outputs the master-data input signal of the master interface or the sensor-data output signal as slave-data output signal.

8 Claims, 3 Drawing Sheets

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26
OEN
DOUT
DIN
TCLK
OEN_M
DOUT_M
DIN_M
TCLK_M
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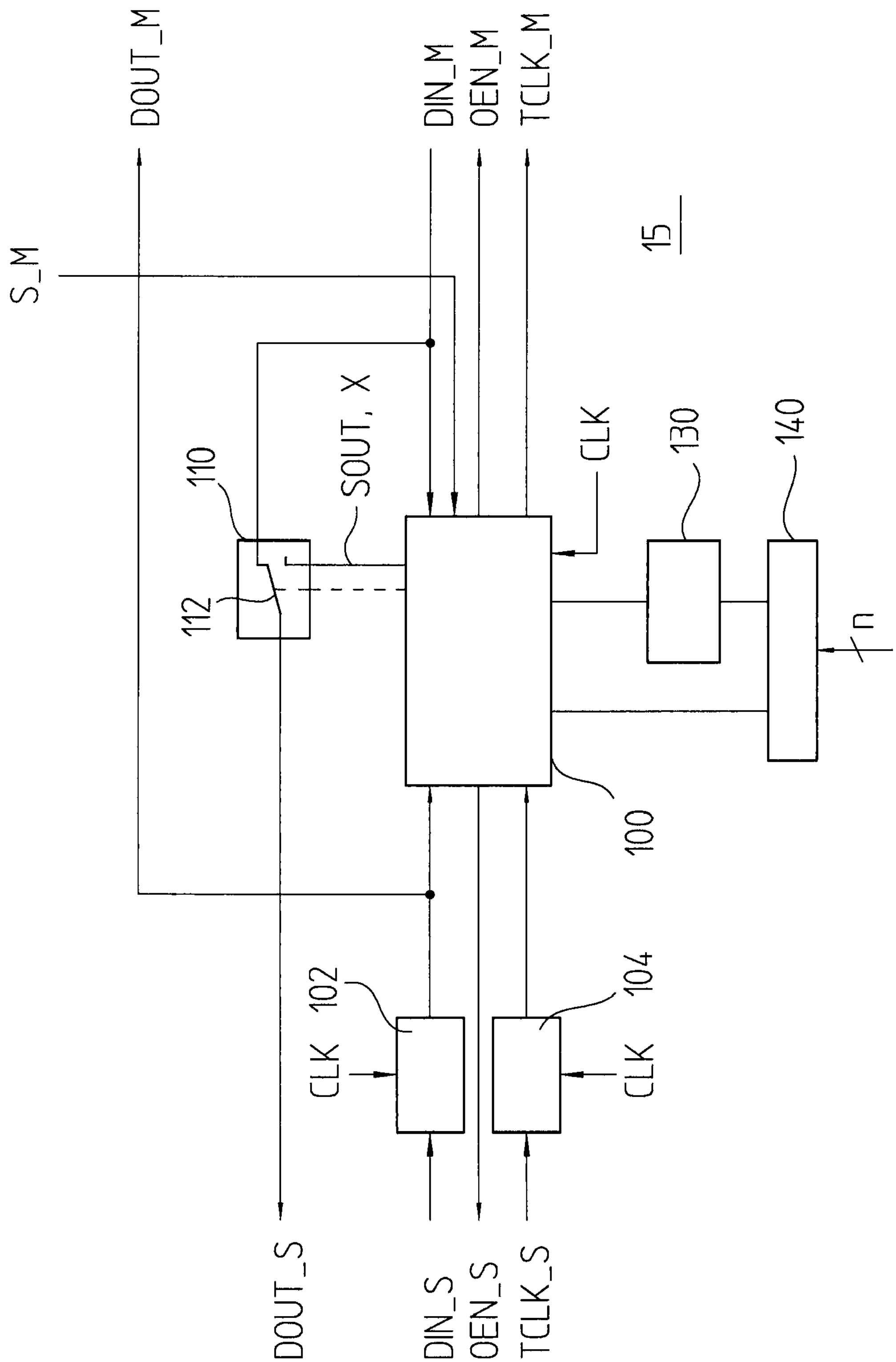
DIN
TCLK

FIG. 1

FIG. 2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OEN_S
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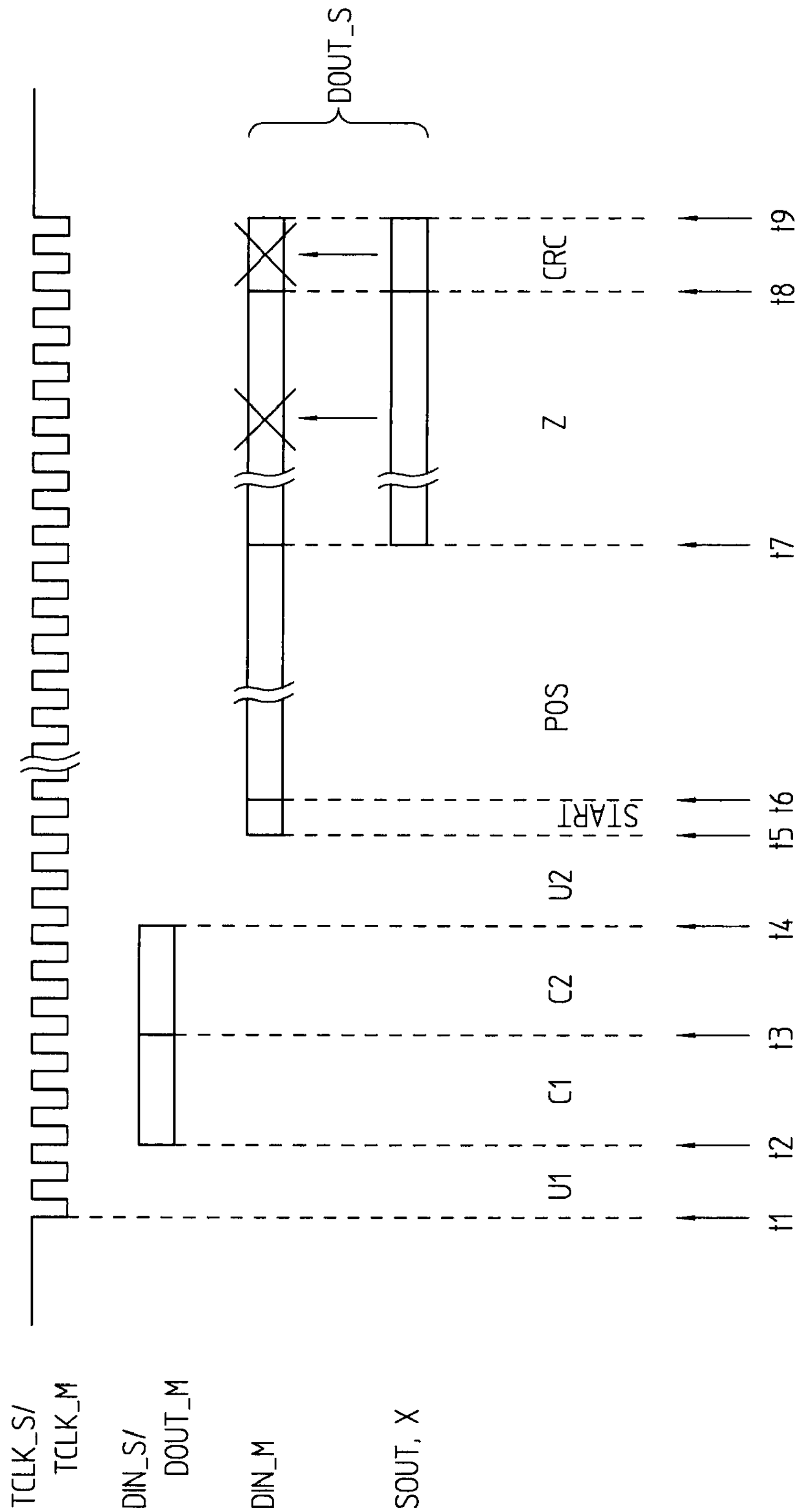
FIG. 3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START
POS
Z
CRC
t1
t2
t3
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t5
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t7
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DEVICE FOR TRANSMITTING SENSOR DATA

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority to Application No. 10 2012 201 170.6, filed in the Federal Republic of Germany on Jan. 27, 2012, which is expressly incorporated herein in its entirety by reference thereto.

FIELD OF THE INVENTION

The present invention relates to a device for transmitting sensor data. In particular, using an interface connection between a measuring device and a control device, measured values of a sensor may be transmitted to the control device with the aid of a device as described herein.

BACKGROUND INFORMATION

Measuring devices which make digital measured values available are being used increasingly in automation technology. In the field of numerical controls, which are used for controlling machine tools, for example, this is true especially for position-measuring devices for measuring linear or rotary movements. Position-measuring devices which generate digital measured values are referred to as absolute position-measuring devices.

Primarily serial data interfaces are used for transmitting absolute position values, since they make do with only a few data-transmission lines, and nevertheless, have high data-transmission rates. Particularly advantageous are so-called synchronous serial interfaces, which have one unidirectional or bidirectional data line and one clock line. Data packets are transmitted via the data line synchronized with a clock signal on the clock line. A multitude of standard digital interfaces have gained acceptance in automation technology. Among popular representatives for synchronous serial interfaces are the EnDat interface of Dr. Johannes Heidenhain GmbH, and the SSI interface. In addition, asynchronous serial interfaces such as Hiperface are also prevalent.

The SSI interface is described, for example, in European Published Patent Application No. 0 171 579. It is a synchronous serial data interface having one unidirectional data line and one unidirectional clock line. Position values are read out from a position-measuring device synchronized with a clock signal on the clock line.

On the other hand, European Patent No. 0 660 209 describes the fundamentals of the EnDat interface. It is likewise a synchronous serial interface which, however, besides the unidirectional clock line, has a bidirectional data line. It is thereby possible to transmit data in both directions—from the numerical control to the position-measuring device and from the position-measuring device to the numerical control. The data is transmitted in synchronization with a clock signal on the clock line, as well.

Moreover, in addition to the data which is acquired or calculated in the measuring device, there is often the desire to also transmit data, which is generated by external devices or sensors, via the existing interface connection, e.g., between a position-measuring device and a numerical control.

For example, German Patent No. 10 2006 041 056 describes providing a rotary encoder with additional interfaces to which external sensors may be connected, the sensor data being able to be processed in the encoder and transmitted via a bus interface to a control.

German Published Patent Application No. 103 06 231 describes an intermediate assembly, to which, on one hand, peripheral equipment, e.g., sensors, may be connected, and which, on the other hand, may be connected by a communication interface to a position-measuring device. The position-measuring device may, in turn, process the sensor data and/or output it via an interface connection in the direction of a numerical control.

Both variants require at least one additional interface on the rotary encoder, which moreover, must also be accessible in the incorporated state.

SUMMARY

Example embodiments of the present invention provide for the possibility of transmitting sensor signals to a control device via an interface connection between a measuring device and the control device, without modifying the measuring device.

According to an example embodiment of the present invention, a device for transmitting sensor data includes: a first slave interface connectable to a master interface of a control device; a first master interface connectable to a slave interface of a measuring device; at least one sensor interface connectable to a sensor; and a circuit configuration including a manipulation unit and a protocol unit. The manipulation unit is adapted to receive a master-data input signal of the first master interface and a sensor-data output signal and to output a slave-data output signal to the first slave interface, and the protocol unit is adapted to receive (a) at least one protocol-relevant interface signal of the first slave interface or of the first master interface and (b) a sensor-data signal of the sensor interface. The protocol unit is adapted to generate the sensor-data output signal from the sensor-data signal, and the protocol unit is adapted to select, based on manipulation rules and the at least one protocol-relevant interface signal, when the manipulation unit outputs the master-data input signal of the first master interface or the sensor-data output signal as the slave-data output signal.

The sensor may include a digital sensor.

The sensor may include an analog sensor, and the device may further include a sensor-data processing unit adapted to generate the sensor-data signal from a sensor signal of the analog sensor.

To rectify inconsistencies in the slave-data output signal caused by an output of the sensor-data output signal, the protocol unit may be adapted to generate a correction-data signal, the manipulation unit may be adapted to receive the correction-data signal, and the manipulation unit may be adapted to output the correction-data signal as the salve-data output signal as a function of the protocol-relevant interface signal.

The device may include an operator interface connectable to an operator-control unit, and the operator interface may be adapted to program and/or operate the circuit configuration.

The circuit configuration may include a manipulation memory adapted to store manipulation rules.

The device may further include an operator interface connectable to an operator-control unit, the operator interface may be adapted to program and/or operate the circuit configuration, and the manipulation memory may be writable via the operator interface.

According to an example embodiment of the present invention, a system includes: a control device including a master interface; a measuring device including a first slave interface; a sensor; and a device for transmitting sensor data as described above.

Further features and aspects of example embodiments of the present invention are described in more detail below with reference to the appended Figures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a device according to an example embodiment of the present invention disposed between a control device and a position-measuring device.

FIG. **2** is a block diagram that illustrates a circuit configuration which is contained in a device according to an example embodiment of the present invention.

FIG. **3** illustrates a simplified data-transmission sequence to illustrate the functioning operation of a device according to an example embodiment of the present invention.

DETAILED DESCRIPTION

FIG. **1** illustrates a device **10**, for manipulating interface signals, arranged between a control device **20** and a measuring device **30**. Control device **20** may be any device of automation engineering or drive engineering that has at least one serial interface capable of communicating with a measuring device connected to the interface. Examples include position displays, numerical controls (NCs), programmable logic controls (PLCs), etc. In the following exemplary embodiments, a numerical control **20** is used representatively as control device **20**. In particular, the measuring device is a position-measuring device **30**, e.g., for measuring the angle of rotation of and/or the number of revolutions performed by a shaft S.

For the exchange of data with numerical control **20**, device **10** includes a slave interface **12** which is connected by a first interface cable **13** to a master interface **22** of an interface controller **24** of numerical control **20**. The device further includes a master interface **18** which is connected by a second interface cable **19** to a slave interface **32** of position-measuring device **30**. The central unit of device **10** includes a circuit configuration **15**, which processes interface signals. The design of circuit configuration **15** is described in greater detail below in connection with FIG. **2**.

The interface cables and the interfaces are equipped in customary manner with suitable plug-in connectors, so that a device according to example embodiments of the present invention may also easily be inserted between numerical control **20** and position-measuring device **30** in the case of pre-installed automation systems or machine tools by, for example, breaking the connection between master interface **22** of numerical control **20** and slave interface **32** of position-measuring device **30**, and providing a connection between master interface **22** of numerical control **20** with slave interface **12** of device **10**, as well as between slave interface **32** of position-measuring device **30** and master interface **18** of device **10**. For the sake of completeness, it should also be mentioned that power is usually supplied to position-measuring device **30** by the interface cable, as well, and a suitable connection is produced in device **10**. This power supply may also be utilized for the operation of device **10**.

Furthermore, in, e.g., a conventional manner, the interfaces may include driver and receiver modules in order, for example, to convert interface signals which are generated and processed as simple, single-ended, digital signals in numerical control **20**, device **10**, and position-measuring device **30**, into signals which are suitable for interference-proof transmission over greater distances. Driver and receiver modules which allow differential transmission of digital signals according to the familiar RS-485 standard are especially widespread. The conversion of digital interface signals into optical signals which are transmitted via optical fibers is familiar and advantageous, as well.

Which data is requested from position-measuring device **30** or transmitted to position-measuring device **30** is determined in numerical control **20** by a control unit **26**, which is connected via an application interface **27**, **28** to interface controller **24**. In this context, interface controller **24** is used as a translation unit which converts communication instructions from general application interface **27**, **28** into interface signals of special master interface **22** of numerical control **20**. The provision of requested data and the processing of received data, respectively, are carried out in position-measuring device **30** in a measuring unit **34**.

Control unit **26** is a program-controlled unit, especially based on a microcontroller or microprocessor. Examples for functions of control unit **26** are the readout and display of position values, as well as the controlling of complex control loops, in that it requests actual values from measuring devices, e.g., position-measuring devices **30**, and from these actual values, ascertains setpoint values for the control of drives.

According to example embodiments of the present invention, at least one sensor interface **300** is provided on device **10**. Sensor interface **300** may be implemented as an analog interface for the connection of an analog sensor **310**, or as a digital interface for the connection of a digital sensor **310**.

If sensor interface **300** is an analog interface, then, in device **10**, a sensor-data processing unit **320** is provided which converts the analog sensor signals, thus the measured value from sensor **310**, into a digital sensor-data signal S_M. Suitable means, e.g., an analog-to-digital converter, is provided in sensor-data processing unit **320** for that purpose.

On the other hand, if sensor interface **300** is a digital interface, then digital sensor-data signal S_M, which includes the measured value from sensor **310**, results directly from connected sensor **310**. It may be that, in principle, sensor interface **300** may be of the same type as slave interface **12** or master interface **18**. However, since they often have a higher complexity and data-transmission speed than is needed for transmitting sensor data, simpler serial interfaces may be used as sensor interface **300**. A few examples for the implementation of sensor interface **300** would be the I2C-, SPI- or JTAG-interface. Moreover, wireless interfaces are also possible, for example, optical according to the IrDA standard or via radio link according to the Bluetooth or ZigBee standard. Sensor interface **300** may be implemented as an RFID (Radio-Frequency Identification) reader unit and the sensor as an RFID-tag, as well.

Digital sensor-data signal S_M is supplied to circuit configuration **15**. In so doing, instantaneous sensor values may be transmitted unprompted and continuously, i.e., at short time intervals, via sensor-data signal S_M to circuit configuration **15**, or else only upon prompting of circuit configuration **15**. In the latter case, circuit configuration **15** assumes control of sensor interface **300**.

On device **10**, an operator interface **16** may also be provided, to which an operator-control unit **40** is connectable with the aid of a further interface cable **45**. Operator interface **16** may be used both for programming and for controlling the functions of circuit configuration **15**. Operator interface **16** is also not restricted to a specific interface variant. For example the same designs are possible which may be selected for sensor interface **300**, as well.

In practice, it is especially advantageous if a conventional personal computer, especially a laptop or notebook computer, is used as operator-control unit **40**. Such devices are usually provided with USB or Ethernet interfaces, which likewise are suitable as operator interface **16**. Instead of a separate operator-control unit **40**, it is also possible to operate device **10** via an additional interface of control device **20**.

Optionally, operator-control elements, e.g., implemented as a keypad and a display unit in the form of a single-line or multi-line display via which circuit configuration **15** is programmable and/or operable, may also be provided in device **10**. In this manner, complex operating functions, e.g., selection of sensor **310** connected to sensor interface **300**, data format, interface protocol, etc., may be performed directly on device **10**, so that the device is operable as an autonomous unit.

In the present example, master interface **22** of numerical control **20** includes an EnDat interface. Therefore, the physical data transmission, as described in European Patent No. 0 660 209 mentioned above, is carried out according to the RS-485 standard in the form of differential signals via two pairs of lines, the first pair of lines being used for the bidirectional transmission of data and the second pair of lines being used for the unidirectional transmission of a clock signal. The data is transmitted in synchronism with the clock signal. For this interface, three interface signals must be managed internally: a clock signal TCLK, a data-input signal DIN, and a data-output signal DOUT. The setting of the data direction, thus, whether the data-output signal is output actively, is accomplished via an enable signal OEN that is switched in accordance with the data-transmission protocol.

In the following, slave interface signals, which are used for the communication of slave interface **12** of device **10** with master interface **22** of numerical control **20**, are denoted as slave-data input signal DIN_S, slave-data output signal DOUT_S, slave clock signal TCLK_S, and slave enable signal OEN_S. Analogously, master interface **18** of device **10** communicates with slave interface **32** of position-measuring device **30** via master interface signals, particularly via a master-data input signal DIN_M, a master-data output signal DOUT_M, a master clock signal TCLK_M, and a master enable signal OEN_M. Corresponding interface signals are, in each case, slave-data input signal DIN_S and master-data output signal DOUT_M, slave clock signal TCLK_S, and master clock signal TCLK_M, as well as master-data input signal DIN_M and slave-data output signal DOUT_S.

FIG. **2** shows a block diagram of a circuit configuration **15**. Protocol-relevant interface signals, e.g., signals which are suitable for detecting and processing the data-transmission protocol, are supplied to a central protocol unit **100**. In the present example, slave-data input signal DIN_S (for the identification of commands which are sent by numerical control **20** to position-measuring device **30**) and slave clock signal TCLK_S (with which the data transmission is synchronized) are protocol-relevant interface signals. Master-data input signal DIN_M may be protocol-relevant as well, for example, when the protocol sequence is a function of response data of position-measuring device **30**, or of the instant certain response data is received. Depending on the instantaneous data direction, which is obtained from the protocol sequence, protocol unit **100** also generates slave enable signal OEN_S and master enable signal OEN_M. Moreover, protocol unit **100** also outputs master clock signal TCLK_M via master interface **18** to position-measuring device **30**.

Additionally, sensor-data signal S_M is supplied to protocol unit **100**. Any digital data-transmission method as desired is suitable for transmitting sensor-data signal S_M to protocol unit **100**. For example, sensor-data signal S_M is transmitted in the form of a digital, serial data stream to protocol unit **100**. As already mentioned above, instantaneous sensor values may arrive unprompted and continuously, i.e., at short time intervals, via sensor-data signal S_M, or the transmission of instantaneous sensor values may be initiated by protocol unit **100**.

In addition to protocol unit **100**, circuit configuration **15** includes a manipulation unit **110**. Master-data input signal DIN_M is supplied to it at a first input, and a sensor-data output signal SOUT, generated in protocol unit **100** from sensor-data signal S_M, as well as possibly a correction-data signal X, are supplied to a second input. At its output, manipulation unit **110** outputs slave-data output signal DOUT_S in the direction of numerical control **20**. A changeover switch **112** in manipulation unit **110** determines whether master-data input signal DIN_M or sensor-data output signal SOUT, or correction-data signal X is output as slave-data output signal DOUT_S. In other words, in place of the data arriving via master-data input signal DIN_M from position-measuring device **30**, changeover switch **112** provides a possibility to output alternative data, particularly sensor-data output signal SOUT, to numerical control **20**.

Changeover switch **112** is controlled by protocol unit **100**.

Protocol unit **100** may be arranged as a state-controlled unit that recognizes information, especially commands, which arrive with the protocol-relevant interface signals from numerical control **20**, and controls changeover switch **112** as a function of this information and according to predefined manipulation rules.

In addition, from sensor-data signal S_M, protocol unit **100** generates sensor-data output signal SOUT, so that it is inserted without gap into the data stream output as slave-data output signal DOUT_S. In the example described, in which the data arrives at manipulation unit **110** as master-data input signal DIN_M from position-measuring device **30** synchronized with master clock signal TCLK_M and is passed on as slave-data output signal DOUT_S in the direction of numerical control **20**, this means that as sensor-data output signal SOUT, protocol unit **100** generates a data sequence which, for output, is likewise output in synchronism with master clock signal TCLK_M to manipulation unit **110**. Moreover, the operations carried out for generating sensor-data output signal SOUT may include a conversion of the data format or an adjustment of the resolution of the sensor value contained in sensor-data signal S_M.

The output of sensor-data output signal SOUT may give rise to inconsistencies in slave-data output signal DOUT_S, which are interpreted as errors in numerical control **20**. In order to rectify such inconsistencies, a correction-data signal X is further able to be generated in protocol unit **100**, which, like sensor-data output signal SOUT, is able to be supplied to manipulation unit **110**, and is able to be output as slave-data output signal DOUT_S to numerical control **20** in place of master-data input signal DIN_M. The point at which correction-data signal X is output in the data transmission is determined by protocol unit **100**, again on the basis of protocol-relevant interface signals, for example, slave-data input signal DIN_S, slave clock signal TCLK_S, or master-data input signal DIN_M.

An example of this: To safeguard the data transmission, i.e., as a possibility for checking whether the data has arrived correctly at numerical control **20**, frequently a checksum CRC (Cyclic Redundancy Check) is generated by the sender (position-measuring device **30**), and is transmitted to numerical control **20**, as well. If the data stream is manipulated and a portion of the transmitted data is replaced by sensor-data output signal SOUT, then checksum CRC no longer matches the transmitted data, and numerical control **20** would recognize an error in this inconsistency. In order to prevent this, in this case, from the data contained in master-data input signal

DIN_M and from sensor-data output signal SOUT, protocol unit **100** generates a new checksum, which takes into account the altered data, and outputs it as correction-data signal X in place of the checksum transmitted by position-measuring device **30**. Analogous to the output of sensor-data output signal SOUT, correction-data signal X is output in synchronism with master clock signal TCLK_M.

Protocol unit **100** operates in synchronism with a working clock-pulse signal CLK, which is either generated in circuit configuration **15**, or is supplied to it from outside. Since the interface signals which arrive at circuit configuration **15** from the direction of numerical control **20**—e.g., slave clock signal TCLK_S and slave-data input signal DIN_S in this example—are asynchronous with respect to working clock-pulse signal CLK, it is advantageous to already synchronize them with working clock-pulse signal CLK at the input of circuit configuration **15** with the aid of synchronization units **102**, **104**. In so doing, these signals are merely time-delayed, but otherwise remain largely unaltered. Since the response data of position-measuring device **30** thereby also arrives in delayed fashion at numerical control **20**, such a delay affects numerical control **20** in the same manner as the use of longer interface cables **13**, **19**. In order to be able to process the interface signals, working clock-pulse signal CLK must have the same or a higher frequency than the maximum frequency to be expected of slave clock signal TCLK_S. In general, the higher the frequency of working clock-pulse signal CLK, the smaller the time delay of the interface signals. Given a maximum frequency of slave clock signal TCLK_S of 10 MHz, a frequency of working clock-pulse signal CLK in the range of 40 to 100 MHz may be provided.

The manipulation rules may be stored permanently in protocol unit **100**, for example. However, it is especially advantageous to provide a manipulation memory **130** whose contents are programmable via a communication unit **140** that communicates with operator-control unit **40** via operator interface **16**. In manipulation memory **130**, it is possible to store which of the commands that numerical control **20** transmits to position-measuring device **30** are to be used in order to transmit sensor-data output signal SOUT in place of the data actually arriving from position-measuring device **30**. In this manner, device **10** may be adapted flexibly to altered requirements.

A programmable component, e.g., a FPGA (Field Programmable Gate Array) may be used as circuit configuration **15**. Such components are able to be reprogrammed at any time, and are therefore best-suited to react to changes and/or expansions of the manipulation possibilities of the device **10**. Microcontrollers are likewise particularly well-suited as circuit configuration **15**, since they are also easy to reprogram and to adapt to altered conditions. For example, circuit configuration **15** may be programmed via operator interface **16**.

FIG. **3** shows a simplified data-transmission sequence to illustrate the operation of device **10**. In particular, slight time delays, caused by the processing or synchronization of the interface signals in circuit configuration **15**, are not shown. The transmission of a special position-request command from numerical control **20** to position-measuring device **30** is shown, whereupon position-measuring device **30** transmits instantaneous position data POS and supplementary data Z to numerical control **20**. For example, the supplementary data may be data from a memory in position-measuring device **30**. To increase transmission reliability, first of all, the position-request command is redundant. For example, it includes a first command block C**1** and a second command block C**2**, including, for example, of 3 bits each, second command block C**2** merely repeating first command block C**1** identically or in inverted fashion. Secondly, position-measuring device **30** transmits a checksum CRC in conclusion.

As a manipulation rule for the position-request command described above, it is stored in device **10** that in place of supplementary data Z, a temperature value of a temperature sensor, which is connected as sensor **310** to sensor interface **300**, is to be transmitted to numerical control **20**. Thus, the manipulation rule determines at what instant manipulation unit **110** must be switched over in order, instead of master-data input signal DIN_M, to output sensor-data output signal SOUT as slave-data output signal DOUT_S, as well as a correspondingly altered checksum CRC.

It should be noted that manipulation rules do not necessarily have to be assigned to commands that are sent within the framework of the data-transmission protocol from numerical control **20** to position-measuring device **30**. Rather, a manipulation rule may be assigned to any information at all which arrives at device **10** or circuit configuration **15** from numerical control **20**, or from position-measuring device **30**. In a simple case, the onset of the clock signal, thus, the beginning of a data transmission, may already be evaluated as information to which a manipulation rule is assigned.

The first line of the data-transmission sequence illustrated in FIG. **3** shows slave clock signal TCLK_S arriving at circuit configuration **15** from numerical control **20**, and (disregarding a delay), master clock signal TCLK_M forwarded by circuit configuration **15** to position-measuring device **30**.

The second line shows slave-data input signal DIN_S, which includes command blocks C**1** and C**2** and is forwarded—possibly after synchronization with working clock-pulse signal CLK in synchronization unit **102**—as master-data output signal DOUT_M in the direction of position-measuring device **30**.

In the third line, master-data input signal DIN_M is illustrated, which contains the response data from position-measuring device **30**.

Finally, the fourth line shows sensor-data output signal SOUT and a correction-data signal X which are generated by protocol unit **100**, the first from sensor-data signal S_M, the latter from the entire data stream transmitted to numerical control **20**.

The time sequence is as follows: After the activation of slave clock signal TCLK_S, initially the data direction is switched over. Assuming that in the quiescent state, slave enable signal OEN_S is switched to active and master enable signal OEN_M is switched to passive, in a first switchover time U**1** between points in time t**1** and t**2**, protocol unit **100** first switches slave enable signal OEN_S to passive and then switches master enable signal OEN_M to active. The switchover is performed in time-stacked fashion in order to avoid data collisions.

As of point in time t**2**, first command block C**1** is transmitted, followed, as of point in time t**3**, by second command block C**2**.

The transmission of second command block C**2** is ended at point in time t**4**. By comparing command blocks C**1**, C**2**, protocol unit **100** is able to determine whether the transmission of the command was error-free. At point in time t**4** at the latest, protocol unit **100** has sufficient information to be able to determine whether interface signals should be manipulated, that is, whether, as in this example, a manipulation rule exists for this command. For example, the manipulation rule is defined in protocol unit **100** or stored in manipulation memory **130**.

The transmission of the command is followed by a second switchover time U**2** from point in time t**4** to point in time t**5**, in which the data direction is switched over. For example, the protocol unit switches master enable signal OEN_M to passive and slave enable signal OEN_S to active.

As of point in time t**5**, the transmission of the response data from position-measuring device **30** to numerical control **20** begins, in the course of which, first a start sequence START is transmitted, which, for example, includes a start bit, followed by several status bits that allow conclusions about the operating state of position-measuring device **30**.

Following start sequence START, position value POS is transmitted as of point in time t**6**.

Conforming to the manipulation rule for the present command, at point in time t**7**, protocol unit **100** switches over switching element **112** in manipulation unit **110**, so that as of this point in time, sensor-data output signal SOUT, which is generated by protocol unit **100** from sensor-data signal S_M, is output as slave-data output signal DOUT_S to numerical control **20** in place of master-data input signal DIN_M.

The transmission of checksum CRC follows immediately as of point in time t**8**, switching element **112** remains in the switched-over position, and protocol unit **100** outputs checksum CRC as correction-data signal X, adapted to the altered data.

At point in time t**9**, the data transmission is ended, and protocol unit **100** as well as manipulation unit **112** return to the initial state.

As the example for manipulation of data traffic between master interface **22** of a numerical control **20** and the slave interface of a position-measuring device **30**, described in connection with FIG. **3**, shows, a device **10** or a circuit configuration **15** provides a simple and effective possibility for inserting measuring data of a sensor **310** into an existing interface communication. It is especially advantageous that neither numerical control **20** nor position-measuring device **30** needs to be modified for this.

What is claimed is:

1. A device for transmitting sensor data, comprising:

a first slave interface connectable to a master interface of a control device;

a first master interface connectable to a slave interface of a measuring device;

at least one sensor interface connectable to a sensor; and

a circuit configuration including a manipulation unit and a protocol unit;

wherein the manipulation unit is adapted to receive a master-data input signal of the first master interface and a sensor-data output signal and to output a slave-data output signal to the first slave interface;

wherein the protocol unit is adapted to receive (a) at least one protocol-relevant interface signal of the first slave interface or of the first master interface and (b) a sensor-data signal of the sensor interface;

wherein the protocol unit is adapted to generate the sensor-data output signal from the sensor-data signal; and

wherein the protocol unit is adapted to select, based on manipulation rules and the at least one protocol-relevant interface signal, when the manipulation unit outputs the master-data input signal of the first master interface or the sensor-data output signal as the slave-data output signal.

2. The device according to claim **1**, wherein the sensor includes a digital sensor.

3. The device according to claim **1**, wherein the sensor includes an analog sensor, the device further comprising a sensor-data processing unit adapted to generate the sensor-data signal from a sensor signal of the analog sensor.

4. The device according to claim **1**, wherein, to rectify inconsistencies in the slave-data output signal caused by an output of the sensor-data output signal, the protocol unit is adapted to generate a correction-data signal, the manipulation unit is adapted to receive the correction-data signal, and the manipulation unit is adapted to output the correction-data signal as the salve-data output signal as a function of the protocol-relevant interface signal.

5. The device according to claim **1**, further comprising an operator interface connectable to an operator-control unit, the operator interface adapted to program and/or operate the circuit configuration.

6. The device according to claim **1**, wherein the circuit configuration includes a manipulation memory adapted to store manipulation rules.

7. The device according to claim **6**, further comprising an operator interface connectable to an operator-control unit, the operator interface adapted to program and/or operate the circuit configuration, the manipulation memory writable via the operator interface.

8. A system, comprising:

a control device including a first master interface;

a measuring device including a first slave interface;

a sensor; and

a device adapted to transmit sensor data, including:

a second slave interface connected to the master interface of the control device;

a second master interface connected to the slave interface of the measuring device;

at least one sensor interface connected to the sensor; and

a circuit configuration including a manipulation unit and a protocol unit;

wherein the manipulation unit is adapted to receive a master-data input signal of the second master interface and a sensor-data output signal and to output a slave-data output signal to the second slave interface;

wherein the protocol unit is adapted to receive (a) at least one protocol-relevant interface signal of the second slave interface or of the second master interface and (b) a sensor-data signal of the sensor interface;

wherein the protocol unit is adapted to generate the sensor-data output signal from the sensor-data signal; and

wherein the protocol unit is adapted to select, based on manipulation rules and the at least one protocol-relevant interface signal, when the manipulation unit outputs the master-data input signal of the second master interface or the sensor-data output signal as the slave-data output signal.

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